ICE 10.491 Spring 2001

Microfluidic Chemical Systems

Paper presentation and Review Guidelines

Each group of 4-3 students will give a presentation and prepare a report of a paper selected from the recent microfluidics literature. The format of the presentation and the report are summarized below. The presentation and report will be graded on the basis of the following items:

1. Summarize the motivation for the microfluidic study and the application. Place the work in context by reviewing similar work in the field.
2. Describe the microfluidic study - including fabrication sequence and microfluidic experiments on a particular application.
3. Give an analysis of relevant chemical engineering concepts used in the paper.
4. Evaluate whether or not the use of microfluidics enables investigations that could not have been done with conventional macroscopic approaches.
5. Consider improvements to the microfluidic device or study. Develop a better design.
6. Evaluate the overall contributions of the work by comparing to other work and macroscopic approaches.

Presentations

Each presentation will be 12 minutes with 3 minutes for questions. The presentation should address the items above and be prepared on overheads. Because of the short time constraint, select one (or at most two) presenters for the group.

The presentations will be scheduled for the last 2-3 days of the module.

Reports

The report should follow the outline above and address all items. The report should be typed (for readability: 1 1/2 or double spaced, 1" margins on all sides, 12 pt font) and not exceed 6 pages excluding graphics, appendix, and literature cited. Include details of the chemical engineering analysis in the Appendix. If any design calculations are made in point 5, place them in the Appendix.

Reports are due in 66-560 March 9 by 3 pm.

Microfluidic Projects:

1. **Use of microreactors to perform difficult/hazardous liquid phase reactions.**

   K. Jaehnisch, M. Baerns, V. Hessel, W. Ehrfeld, V. Haverkamp, H. Loewe, Ch. Wille, A. Guber," Direct fluorination of toluene using elemental fluorinein gas/liquid microreactors," *Journal of Fluorine Chemistry* **105,** 117-128 (2000).

2. **Use of microreactors to perform difficult/hazardous gas phase reactions**

   Michael T. Janicke, Harry Kestenbaum, Ulrike Hagendorf, Ferdi Schuth, Maximilian Fichtner, and Klaus Schubert "The controlled oxidation of hydrogen from an explosive mixture of gases using a microstructured reactor/heat exchanger and Pt/Al_2O_3 catalyst," *Journal of Catalysis* **191**, 282–293 (2000).

3. **Soft lithography as a method for making integrated microfluidic systems for biological applications.**

   Hou-Pu Chou,Charles Spence,Axel Scherer, and Stephen Quake, "A microfabricated device for sizing and sorting DNA molecules," *Proc. Natl. Acad. Sci. USA*, **96,** 11–13 (1999).

   Marc A. Unger, Hou-Pu Chou, Todd Thorsen, Axel Scherer, and Stephen R. Quake," Monolithic Microfabricated Valves and Pumps by Multilayer Soft Lithography," Science 288, 113-116 (2000).

4. **Microreactors incorporating solid particles for reactions and separations.**

   Helene Andersson, Wouter van der Wijngaart, Peter Enoksson, Goran Stemme, "Micromachined flow-through filter-chamber for chemical reactions on beads," *Sensors and Actuators* **B 67**, 203–208 (2000).

   Richard D. Oleschuk, Loranelle L. Shultz-Lockyear, Yuebin Ning, and D. Jed Harrison, "Trapping of Bead-Based Reagents within Microfluidic Systems: On-Chip Solid-PhaseExtraction and Electrochromatography," *Anal. Chem.* **72**, 585-590 (2000).

5. **Hydrogels as materials for making integrated microfluidic systems for biological applications.**

   David J. Beebe, Jeffrey S. Moore, Joseph M. Bauer, Qing Yu, Robin H. Liu, Chelladurai Devadoss and Byung-Ho Jo, "Functional hydrogel structures for autonomous Flow control inside microfluidic channels," *Nature* **404,** 588-590 (2000).

David J. Beebe, Jeffrey S. Moore, Qing Yu, Robin H. Liu, Mary L. Kraft, Byung-Ho Jo, and Chelladurai Devadoss, "Microfluidic tectonics: A comprehensive construction platform for microfluidic systems," *Proc. Natl. Acad. Sci. USA*, **97,** 13488–13493 (2000).

6. **Microreactors with immobilized enzymes**

   J Drott, K Lindstrom, L Rosengren and T Laurell, Porous silicon as the carrier matrix in microstructured enzyme reactors yielding high enzyme activities, *J. Micromech. Microeng*. **7** 14–23 (1997).

7. **Using microreactors to create emulsions and controlling reactions in dispersed liquid phases**.

   Verena Haverkamp, Wolfgang Ehrfeld, Klaus Gebauer, Volker Hessel, Holger Löwe, Thomas Richter, and Christian Wille, "The potential of micromixers for contacting of disperse liquid phases," *Fresenius J Anal Chem* **364** 617–624 (1999).

8. Find your own microreactor papers and propose a project.